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sierra®

INSTRUCTION MANUAL

IN-CIRCUIT TRANSISTOR TESTER
MODEL 219C

SIERRA ELECTRONIC DIV.
OF
PHILCO®
A SUBSIDIARY OF Ford Motor Company

Carlton L. Wyant

INSTRUCTION MANUAL

IN-CIRCUIT TRANSISTOR TESTER
MODEL 219C

Stock No. A02521900C

Price $3.00

SEPT 1966

Manufactured by

SIERRA ELECTRONIC DIV.

OF

PHILCO

A SUBSIDIARY OF *Ford Motor Company*

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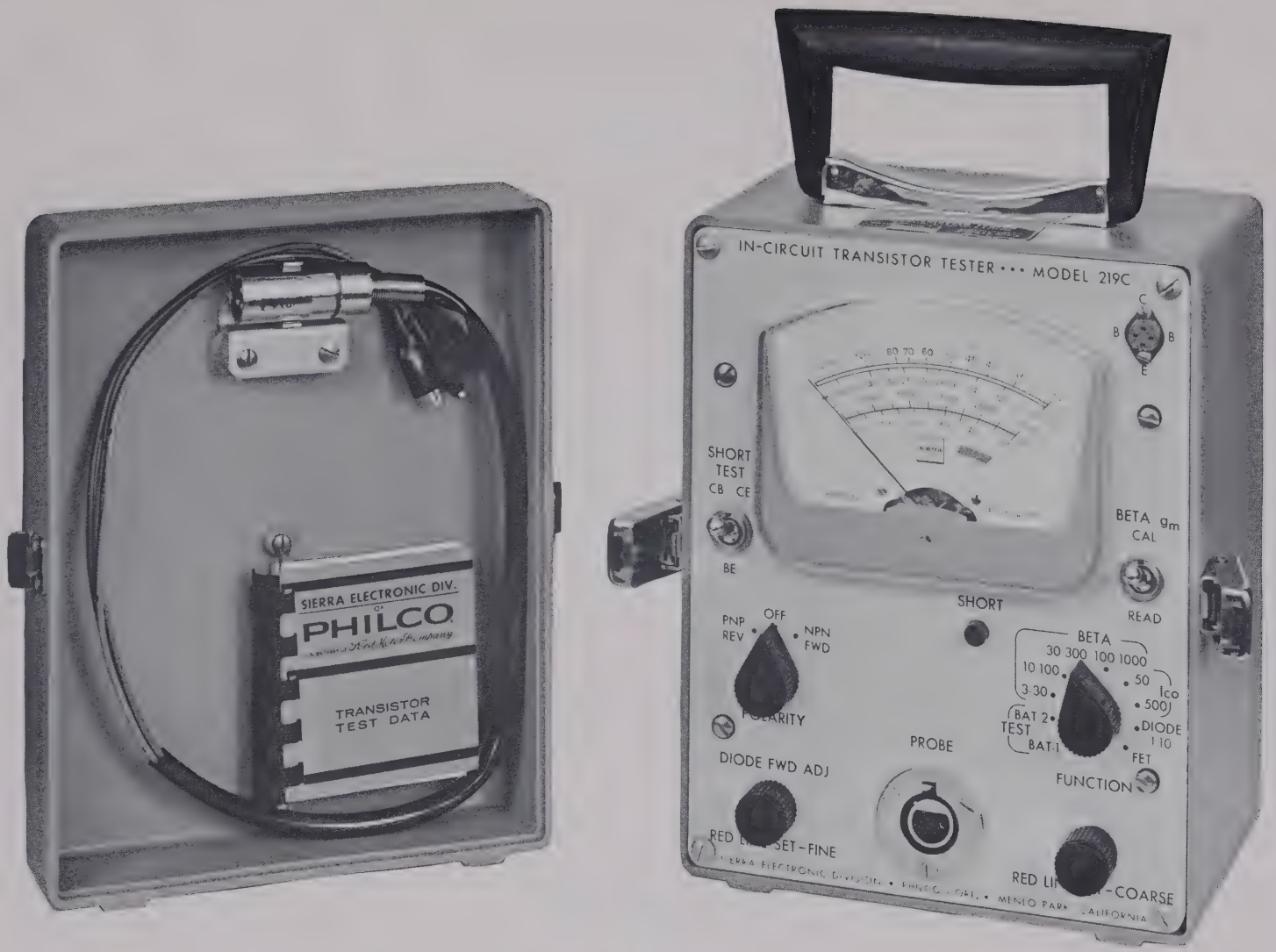


Figure 1-1. Model 219C In-Circuit Transistor Tester

SECTION I
GENERAL

A. PURPOSE

The Sierra Model 219C Transistor Tester (Patent No. 2,922,544) is designed to make rapid, in-circuit transistor beta measurements with a high degree of accuracy. The instrument may also be used for out-of-circuit measurement of transistor leakage current I_{co}, for indicating diode reverse-to-forward ratio and for measuring the transconductance, g_m, of Field Effect transistors. In addition, a shorted junction indicator for the transistor being tested is provided. The instrument is designed to provide maximum possible accuracy in the presence of small shunting impedances in the circuits external to the transistor. When a shunting impedance between transistor electrodes is greater than 500 ohms, there is little difference in the accuracy between in-circuit and out-of-circuit beta measurements. Significant in-circuit beta measurements can be made with shunting impedances as low as 25 ohms with some loss in accuracy. See specifications paragraph C.

B. DESCRIPTION

The Model 219C uses solid state components throughout and is battery operated. The unit is housed in a sturdy plastic case fitted with a carrying handle for easy portability. The components are mounted on epoxy-glass circuit boards fastened to the front panel with standoff spacers. Batteries are mounted on the rear circuit board. The circuit is made up of an oscillator and amplifier as the signal source, and a tuned amplifier and meter rectifier for readout. The meter is calibrated to read beta, diode reverse-to-forward ratio, field effect transistor g_m and transistor leakage current.

A test cable is furnished for in-circuit use with miniature alligator clips to fasten to transistor leads for circuit board in-circuit transistor testing. Clips are provided to hold the cable inside the cover. A test socket is mounted on the front panel.

C. SPECIFICATIONS

TEST RANGES

Transistor	
Beta, Maximum	30, 100, 300, 1000
I_{co}	0-50 μa 0-500 μa
Diode	
Reverse-to-forward Ratio	1:10
Field Effect Transistor	
Transconductance, g_m	0-2500 μmhos

ACCURACY

Beta, Out-of-Circuit	5%
Beta, In-Circuit (500 loading)	
Typical Deviation from Out-of-Circuit Reading	5%
I_{co}, Out-of-Circuit	5%
Diode, Out-of-Circuit	10%
g_m, Out-of-Circuit	5%
g_m, In-Circuit (100 G-S, 4K D-S)	
Typical Deviation from Out-of-Circuit Reading	10%

OPERATING TEMPERATURE

0-65°C

POWER REQUIREMENTS

Battery Type	Quantity	Expected Life
Mercury, 12.15 volts	1	280 hours
Zinc-carbon, 1.5 volts	4	200 hours
Zinc-carbon, 1.5 volts	1	Shelf Life

*For low shunting resistances the deviation from out-of-circuit readings may be greater.

INPUT CONNECTORS	
In-Circuit	
Test Cable	Miniature Alligator Clips
Out-of-Circuit	Test Socket
DIMENSIONS, Overall	
Height	10 inches
Width	7-5/8 inches
Depth	6-1/2 inches
WEIGHT	7-3/4 Pounds

D. BATTERY INSTALLATION

Batteries are shipped wrapped in a separate fiberboard container in the instrument shipping carton. To install or replace batteries the instrument must be removed from its case. Procedure follows:

Remove four (4) screws in corners of front panel.

Carefully set unit upright.

Slide unit out of case.

Place 12.15 volt Mercury battery BT1 in clips at top of rear circuit board. Observe polarity.

Place five (5) zinc-carbon 1.5 volt cells in clips in lower left-hand corner of rear circuit board. Observe polarity.

Slide unit into case, lay on back and insert screws in corners of front panel.

Batteries should always be removed from instrument before storing or shipping.

Zinc-carbon batteries, BT2-BT6 may be replaced with 1.5V alkaline cells, if desired, to obtain somewhat greater battery life.

SECTION II
OPERATION

A. OPERATING CONTROLS AND INDICATORS

Control or Indicator	Use	Schem. Ref. No.
FUNCTION (Rotary Switch)	Battery Tests Range Switch For: Beta; Leakage Current, I_{co}; Diode Reverse-To-Forward Ratio; Field Effect Transistor Transconductance.	S2
POLARITY (Rotary Switch)	Selects Bias Battery Voltage To Transistor or Diode Under Test Power OFF Switch	S3
SHORT TEST (Spring-Return Toggle Switch)	CB CE Position: Collector-Base, Collector-Emitter Junction Short; or Low External Shunt Resistance. BE position: Base-Emitter Short; or Low External Shunt Resistance.	S1
SHORT (Red Panel Light)	Indicates Transistor Junction Short or Low External Shunt Resistance when Light Comes On	DS1
BETA/g_m (Spring-Return Toggle Switch)	CAL Position: RED LINE SET For Instrument Calibration. Meter indicates Microamps or Reverse-To-Forward Ratio READ Position: Meter indicates Beta or g_m	S4
RED LINE SET-COARSE (10-Turn Potentiometer)	Coarse Calibration Signal Level Adjustment	R64

Control or Indicator	Use	Schem. Ref. No.
RED LINE SET-FINE (Potentiometer)	Fine Calibration Adjustment Diode Calibration Adjustment	R65

B. OPERATING PROCEDURE

1. Battery Test

a. Place FUNCTION switch in the BAT-1 TEST position. Meter should read in green sector. If reading is below green sector replace batteries BT2 through BT6 before making transistor tests. See Section I paragraph D for replacement procedure.

b. Place FUNCTION switch in BAT-2 TEST position. Place POLARITY switch in NPN position. Meter should read in green sector. If reading is below green sector replace battery BT-1 before making transistor tests.

c. BT6 is good for normal shelf life so no test is provided. A new BT6 cell should be installed whenever BT2 - BT5 are replaced.

2. Beta Test (In-Circuit)

a. Turn POLARITY switch to OFF and FUNCTION switch to BETA.

b. Connect the test cable to PROBE jack. (Be sure there is no transistor in the front panel test socket when using probe.)

c. Attach alligator clips to transistor leads. Cable is color coded as follows:

BLUE - COLLECTOR (DRAIN)
GREEN - BASE (GATE)
YELLOW - EMITTER (SOURCE)

d. Turn RED LINE SET-COARSE full counterclockwise. (This is a ten turn potentiometer. There is no positive stop at the end of travel but an increase in torque is noticeable at the full counterclockwise point.)

CAUTION

Do not leave RED LINE SET-COARSE control in advanced clockwise position. Excessive drive may cause the next transistor tested to be damaged when it is connected or plugged into the tester.

e. Turn POLARITY switch to correct position for transistor type to be tested (Germanium usually PNP, Silicon NPN).

f. If SHORT light comes on, it may be caused by any one of the following:

(1) Transistor junction is shorted.

(2) External circuit CE shunting impedance is less than approximately 100 ohms. If in doubt as to whether (1) or (2) is the case, remove transistor from circuit and test.

(3) POLARITY switch is in wrong position. If SHORT light comes on in either POLARITY position (1) or (4) is the case.

(4) RED LINE SET-COARSE control left at too high a setting.

If shunting resistance is less than 100 ohms the test may be carried out even through the SHORT light stays on, taking into consideration the reduced accuracy as given in Specification Section 1 paragraph C.

g. Press down SHORT TEST to BE position. If SHORT light comes on either:

(1) The base-emitter junction is shorted.

(2) Or the external resistance shunting the base-emitter junction is approximately 50 ohms or less. If (2) is the case, test may be carried out as noted in 2.f(4) above.

h. Adjust RED LINE SET-COARSE until meter reads on RED LINE. Use RED LINE SET-FINE for exact adjustment. This calibrates instrument for transistor being tested. If meter pointer does not move when control is advanced junction of transistor under test is open.

i. Press down BETA/g_m switch to READ position. If meter pointer swings to the left beyond the 120/40 scale mark, set FUNCTION switch to a higher BETA range. If meter pointer swings all the way to the right, set FUNCTION switch to a lower BETA range.

j. Read BETA on meter scale corresponding to FUNCTION switch BETA range setting.

NOTE

If a diode or another transistor is connected in the base circuit of the transistor under test, the base lead should be disconnected and isolated in order to obtain an accurate indication of beta.

3. Beta Test (Out-Of-Circuit)

a. Place POLARITY switch in OFF position.

b. Place transistor to be tested in test socket on instrument panel. Probe cable should be removed to make certain leads are not inadvertently shorted. If more convenient, use test cable for connection to transistor instead of placing it in test socket.

c. Turn POLARITY switch to correct position for transistor type to be tested.

d. If short light comes on:

(1) Transistor collector-base or collector-emitter junction is shorted and no further test is necessary.

(2) POLARITY switch is in the wrong position. If short light comes on in either POLARITY position transistor junction is shorted.

e. Follow procedure given above in paragraph 2., g. through j.

4. I_{co} Test (Out-Of-Circuit Only)

The I_{co} test must be made with transistor out of circuit due to the very small currents involved.

a. Place POLARITY switch in OFF position.

b. Insert transistor in test socket. If more convenient use test cable for connection to transistor instead of placing it in socket.

c. Set FUNCTION switch to I_{CO} 500 position.

d. Turn POLARITY switch to proper position for transistor type being tested.

e. Read current on microamp scale.

f. If meter indication is very small turn FUNCTION switch to I_{CO} 50 position. (It should be remembered that I_{CO} is a very temperature dependent parameter. The warmth transmitted to the transistor by holding it in the fingers will cause this current to increase.)

5. Diode Test (Out-Of-Circuit Only)

a. Place POLARITY switch in OFF position.

b. Turn DIODE FWD ADJ to counterclockwise position.

c. Insert diode into test socket, anode to C and cathode to E. If more convenient use test cable for connection to diode instead of placing it in socket.

d. Place POLARITY switch in FWD position.

e. Turn DIODE FWD ADJ control until meter pointer comes up to red mark.

f. Turn POLARITY switch to REV position.

g. Read the reverse-to-forward ratio on the 10-100 BETA/DIODE scale and divide by 10.

6. Field Effect Transistor Test (In-Circuit or Out-Of-Circuit)

a. Place POLARITY switch in OFF position.

b. Insert transistor into test socket.

DRAIN to C
GATE to B
SOURCE to E

If more convenient use test cable for connection to transistor instead of placing it in socket.

c. Place FUNCTION switch in FET position.

d. Turn POLARITY switch to NPN position for an N-channel FET and PNP for a P-channel FET.

e. Adjust RED LINE SET control until meter pointer is on the red line.

f. Press down BETA/g_m switch to READ position.

g. Read transconductance on g_m meter scale.

SECTION III
THEORY OF OPERATION

A. BETA MEASUREMENT

1. General

When measuring beta of a transistor removed from the circuit, conventional ac or dc current measurements suffice. However, when measuring beta of a transistor connected in the circuit, these methods are inadequate. This is due to the difficulty of separating actual transistor junction currents from apparent junction currents. These apparent currents results from resistances and reactances that are an integral part of the circuit, shunting the transistor junctions. The Sierra Model 219C In-Circuit Transistor Tester employs a method that practically eliminates erroneous readings caused by these circuits extraneous to the transistor.

2. In-Circuit Second Harmonic Method

Figure 3-1 is a simplified diagram of the 219C tester when measuring beta. See Figure 4-1 for overall schematic diagram.

The transistor beta parameter is defined as the current gain of a common-emitter transistor configuration, and is expressed by the equation

$$B = \left.\frac{\Delta I_c}{\Delta I_b}\right| E_o = \text{a constant}$$

where B = beta

ΔI_c = change in collector current caused by a change in base current

ΔI_b = change in base current

E_o = output voltage

When an ac signal is applied to the base of a common-emitter circuit with no base bias voltage, transistor conduction results in a current wave shape (approximately half sine wave) having a high second-harmonic content in both the base and collector currents. These second-harmonic currents are directly related to transistor beta. They have no relation to currents flowing in the circuits extraneous to the transistor. These extraneous currents flow through linear components and thus no second-harmonic currents are generated

SIMPLIFIED DIAGRAMS

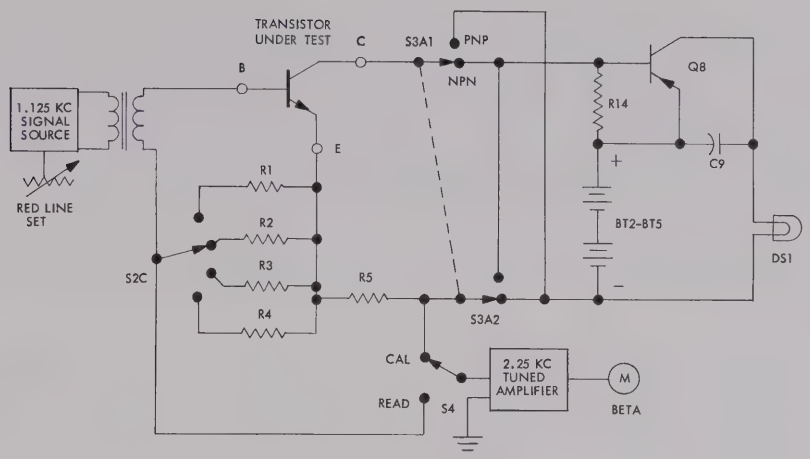


Figure 3-1. Beta Test

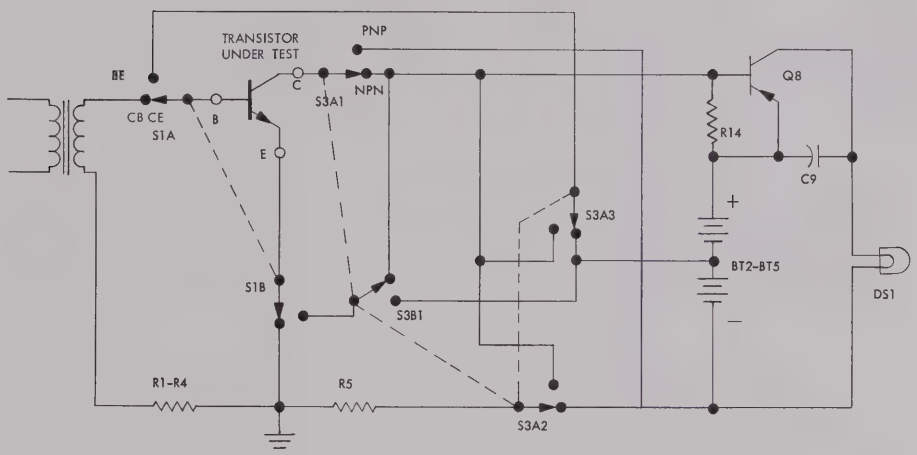


Figure 3-2. CE CB Short Test, NPN Transistor

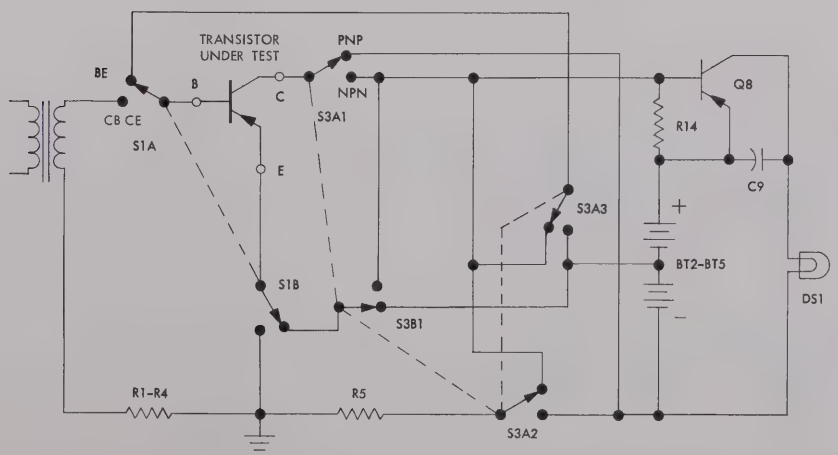


Figure 3-3. BE Short Test, PNP Transistor

outside the transistor. By measuring the relative values of the second-harmonic content of the base and collector currents, and applying the beta equation, an accurate determination of beta can be made. However, if there is a nonlinear device in the base circuit, such as another transistor or a diode, second-harmonic currents will be developed and can cause excessive error. Such a device should be disconnected for maximum accuracy.

From the basic beta equation, if I_c is held constant, beta will be inversely proportional to ΔI_b.

In the Model 219C Transistor Tester, the second harmonic collector current of the transistor under test is set to a predetermined value with the RED LINE SET adjustment and is thus a constant. The base second harmonic current is then measured and indicated on the readout meter. The readout meter is calibrated directly in terms of beta as an inverse function of the current through the meter.

As shown in Figure 3-1, a 1.125 kc test signal is applied to the base of the transistor under test. The 2.25 kc (second harmonic) tuned amplifier is switched across collector load resistor R5, and the test signal is adjusted so that the readout meter indicates at the red line. When the tuned amplifier is switched across one of the series base resistors, R1-R4, the reading obtained on the meter indicates the beta of the transistor under test.

Currents do flow in the circuits extraneous to the transistor and this shunting effect reduces accuracy to a certain extent. Error does not begin to be significant, however, until these resistances are much less than 500 ohms. In-circuit readings may be taken with shunting resistances as low as 25 ohms, although accuracy will be considerably reduced at these low values.

B. INSTRUMENT CIRCUITS

1. Test Signal Source

The test signal source consists of a stable oscillator for frequency generation and an amplifier to raise the test signal to a suitable level.

a. 1.125 kc Oscillator. Q4 is connected in a common-base colpitts oscillator circuit in which L51-C51-C52 are the frequency determing components. L51 is tapped so that part of the inductance can be shunted out to raise the frequency to 2.25 kc when required for the Field Effect transistor test. Coupling to the amplifier is through two capacitors C54, C55. These capacitors also serve to block the dc bias currents from the RED LINE SET controls R64, R65.

b. Signal Source Amplifier. The signal is amplified by common-emitter amplifier Q5 and coupled to the push-pull output amplifier Q6-Q7 through transformer T51.

Sufficient signal level is provided by this amplifier to obtain approximately three milliamperes average current into the collector of the transistor under test. This level is necessary to make the RED LINE SET calibration adjustment. One secondary of output transformer T52 provides negative feedback to the emitter of Q5 to reduce distortion and to reduce the output impedance of the amplifier, both of which are necessary for maximum accuracy of "in-circuit" beta measurement. The other secondary couples the output of the signal source to the transistor under test.

2. Applied Test Signal

The output of the signal source amplifier is applied to the base of the transistor under test. Since the base of the transistor is maintained at approximately the same dc voltage as the emitter (no bias) the signal appearing across both the base and the collector sampling resistors of the transistor under test will be half-sine-wave pulses. This waveform, which is rich in second harmonic signal content, provides the desired test signal.

3. 2.250 kc Tuned Amplifier

Second harmonic voltages developed across the sampling resistors in the collector or base circuit of the transistor under test are amplified and rectified to provide a suitable meter readout. Since the fundamental frequency is also present, tuned circuits are necessary in the tuned amplifier to pass the second harmonic signals and reject the fundamental frequency.

The first tuned circuit is L1-C2, a series resonant circuit in the emitter of common-base amplifier Q1. This circuit arrangement provides sufficient selectivity to reduce the fundamental to a point where it will not overdrive the input transistor. The second tuned circuit is the parallel resonant circuit, L2-C4, in the collector of common-emitter amplifier Q2. These circuits provide approximately 50 db rejection to the fundamental. Further amplification is provided by the common-emitter amplifier Q3 before the signal is applied to the bridge type meter rectifier CR1-CR4. Rectifier output is connected to the meter through switches S2B, S2G.

C. OTHER TEST CIRCUITS

1. Short Indicator Circuit

To indicate shorted junctions in the transistor under test, or low shunting resistance in the circuits external to the transistor, a solid-state switch and indicator light are employed. R14, connected between emitter and base of transistor switch Q8, is in series with the test circuit in all test positions of FUNCTION switch, S2. See simplified schematics Figure 3-1 through 3-6. If current flow in the test circuit becomes excessive the voltage drop across R14 biases Q8 into conduction causing SHORT indicator light, DS1, in the collector circuit of Q8, to come on.

With the SHORT TEST switch in the normal, CB CE, position an external shunting resistance of approximately 100 ohms between collector and base or emitter will cause the SHORT indicator to light. In the BE SHORT position an external shunting resistance of approximately 50 ohms between base and emitter will cause the SHORT light to come on.

2. Short Test

The SHORT TEST applies a reverse bias to the junctions of the transistor under test. If the junction is normal only the regular leakage current will flow and there will be no SHORT indication. If the junction is shorted the excessive current flow will cause the SHORT indicator light to come on. (Open junctions will be detected in the Beta test.)

When the SHORT TEST switch, S1, is in the normal, CB CE, position the test battery, BT2 - BT5, is connected in series with the short indicator circuit to reverse bias both the CB and CE junctions of the transistor under test. See Figure 3-2. In the BE SHORT TEST position, S1 depressed, only the 3 volts of BT2, BT5 is applied through the short indicator circuit to reverse bias the BE junction. See Figure 3-3. Although this voltage is sufficient for the test, it is low enough to protect transistors with a low BE voltage rating from damage.

3. I_{co} Leakage Test Circuit

For this test, with FUNCTION switch S2 in the 50 microamp position, the six volt test battery is connected to reverse bias the collector-base junction of the transistor under test. The emitter must be open. The meter and a one thousand ohm current limiting resistor are also in the circuit. Leakage current is read directly on the meter 50 microamp scale. In the 500 microamp FUNCTION switch position a meter range shunt, R7, is switched across the meter to increase the current range. See Figure 3-4. It will be noted that the emitter of the transistor under test is connected to ground. This electrode is effectively open since the remainder of the circuit is isolated from ground.

4. Diode Test Circuit

In the diode test position the six volt test battery is connected in series with the diode under test in the forward conduction mode. The readout meter and its range shunt, R9, a current limiting resistor, R18, and DIODE FWD. ADJ. control, R19, are also in the series circuit. See Figure 3-5. For a reading to be made the meter is set to the red line as a calibration point with the DIODE FWD. ADJ. control. When the battery polarity to the diode is reversed with polarity switch S3 (meter polarity is reversed at the same time), the reverse-to-forward ratio is indicated on the Beta/Diode scale and read from 1 to 10.

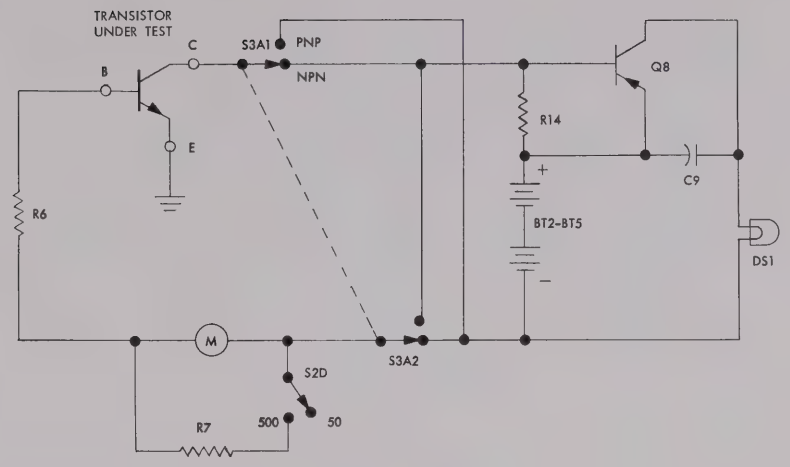


Figure 3-4. I_{CO} Test

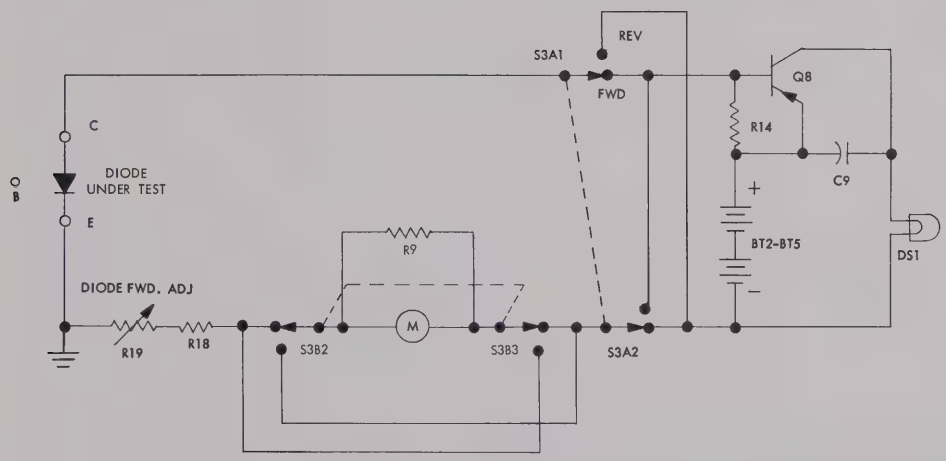


Figure 3-5. Diode Test

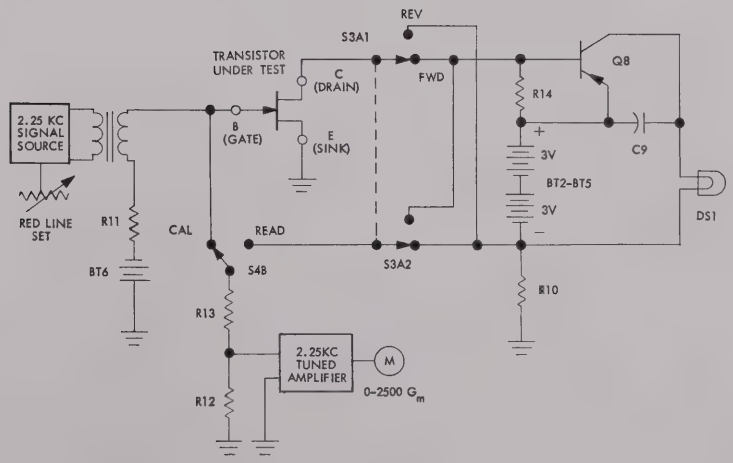


Figure 3-6. Field Effect Transistor Test

5. Field Effect Transistor Test

The field effect transistor is very similar to a vacuum tube in its operation so g_m is the significant factor for measurement.

$$\text{Since } g_m = \frac{\Delta i_o}{\Delta e_{in}}, \text{ and } i_o = \frac{\Delta e_o}{R_l}$$

$$\text{then } g_m = \frac{\Delta e_o}{\Delta e_{in} R_l}$$

where

g_m = transconductance

Δi_o = change in output current due to change in input voltage

Δe_{in} = change in input voltage

Δe_o = change in output voltage due to change in input voltage

R_l = load resistance

If e_{in} is held constant, then g_m varies directly with e_o, since R_l is constant. In making a measurement, e_{in} is held constant by adjusting the input signal so that the meter reads to the Red Line when BETA/g_m switch, S4, is in the CAL position. With switch, S4, in the READ position the voltage developed across load resistor, R10, is measured and converted directly to g_m by the meter scale.

Since harmonic generation is not required for field effect transistor testing, a bias battery, BT6, is connected to the gate electrode to provide for linear amplification of the test signal. In addition, a test signal of 2.25 kc is required since the meter amplifier is tuned to that frequency. To change the oscillator frequency to 2.25 kc, switch S2H shunts out part of the tuning inductance in the collector circuit of the signal source oscillator Q4.

Figure 4-2. Rear Circuit Board Components

Figure 4-1. Rear of Front Panel Components

SECTION IV
MAINTENANCE

A. PREVENTIVE MAINTENANCE

The clips holding the batteries should be examined about every two months for signs of corrosion and cleaned if necessary. Wipe clean with rag. If necessary, polish with crocus cloth.

If the instrument is not to be used for some time, or is to be stored, the batteries should be removed and the battery clips cleaned. See paragraph D for instrument disassembly.

B. TROUBLE SHOOTING

1. Component Troubles

Expected component failure will usually be according to the following order from most likely to least likely: Weak or dead batteries, conductor breakage in most used test cable, erratic contact or operation of most used controls, indicator light failure, instrument transistor beta and leakage current change, capacitor decreased leakage resistance, resistor change in value. Aside from normal expectations, a transistor junction short in the transistor tester circuit may cause the failure of one or more resistors due to excessive current flow.

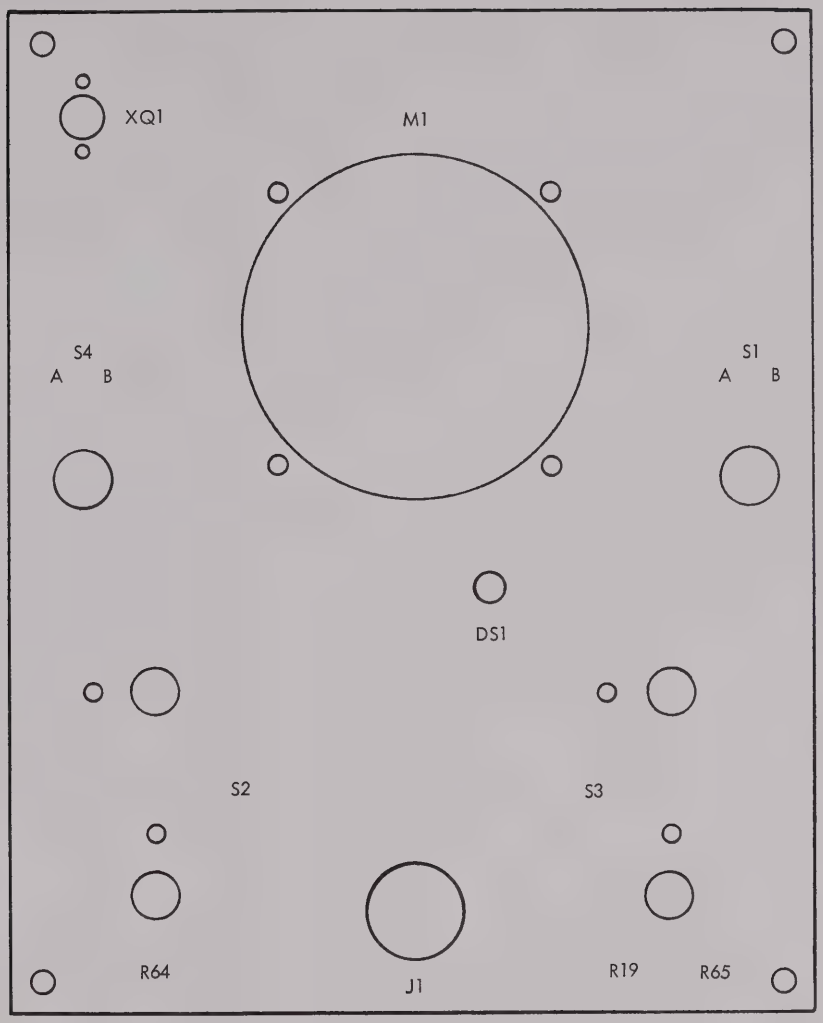
2. Functional Unit Checking

If the cause of improper functioning is not immediately apparent, the following procedure will help to localize the trouble to one functional unit. Refer to Figure 4-1 for overall schematic diagram.

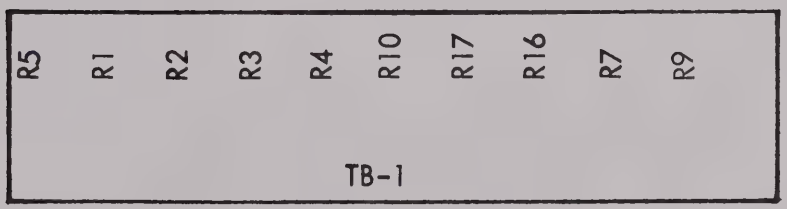
a. Check battery condition. Make sure battery terminals are making good contact with their connector clips.

b. Check output of reference oscillator-amplifier with switch in BETA position. Use calibration procedure given in paragraph 3 below to determine proper output. Check switch continuity from amplifier output to transistor under test.

c. If oscillator amplifier unit is functioning properly, place a transistor known to be good in the test socket. If meter does not indicate when RED LINE SET-COARSE control is advanced; check continuity through switches to 2.25 kc tuned amplifier and from amplifier output to meter. Check amplifier and rectifier.(Switch deck A is next to panel.)



Front Panel, Rear View



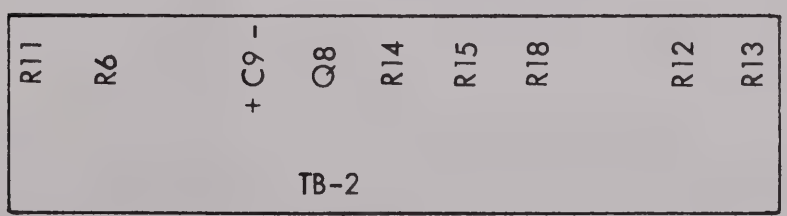


Figure 4-3. Component Location, Terminal Boards and Rear of Front Panel

Figure 4-4. Rear Circuit Board Component Location

d. When a functional unit containing the trouble has been isolated, signal tracing techniques, using an oscilloscope, may be employed to isolate the difficulty to a particular area. Components related to that area then may be individually checked.

e. The SHORT indicator may be checked by connecting a 82-100 ohm resistor between C and E in one of the test sockets. If the light does not come on and batteries are o.k., Q8 is probably faulty.

C CALIBRATION

In the event of parts replacement or normal aging of the transistor compoents, re-calibration of the meter amplifier may be necessary.

Procedure is as follows:

1. With POLARITY switch in the OFF position, zero meter pointer with mechanical zero set adjustment.

2. Place a silicon transistor, known to be good, in one of the test sockets.

3. Set FUNCTION switch to the proper BETA range fro the test transistor being used.

4. Turn RED LINE SET-COARSE to maximum CCW. (Control turns somewhat harder when it reaches end of range.)

5. Connect a dc clip-on ammeter on the collector lead to the socket containing the test transistor. Set ammeter for current direction into the collector and switch to the 10 ma scale.

6. Turn POLARITY switch on transistor tester to NPN.

7. Adjust RED LINE SET-COARSE until the ammeter reads 3 ma ±10%.

8. Adjust R34 (center-left on rear circuit board) until meter pointer is on the red line. Gain of meter amplifier is now properly set.

D. DISASSEMBLY FOR SERVICING

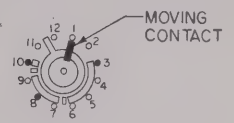
Remove four (4) screws in corners of front panel and slide instrument out of case.

Remove four (4) screws which fasten rear circuit board to standoff spacers. Since all connecting wires are cabled at the top of this board it may now be folded out from the bottom and the instrument laid open on the test bench. This gives maximum access to components.

NOTES:

1. ALL ROTARY SWITCHES SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION AS VIEWED FROM FRONT OR KNOB END OF SWITCH.
2. ALL OTHER SWITCHES SHOWN IN NORMAL POSITIONS.
3. RESISTOR VALUES ARE IN OHMS AND 1/4 WATT UNLESS OTHERWISE NOTED. $K=10^3$, $M=10^6$.
4. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
5. MOVING CONTACT ELEMENT IS REPRESENTED BY BLACK BAR IN ROTARY SWITCH SYMBOLS.

EXAMPLE

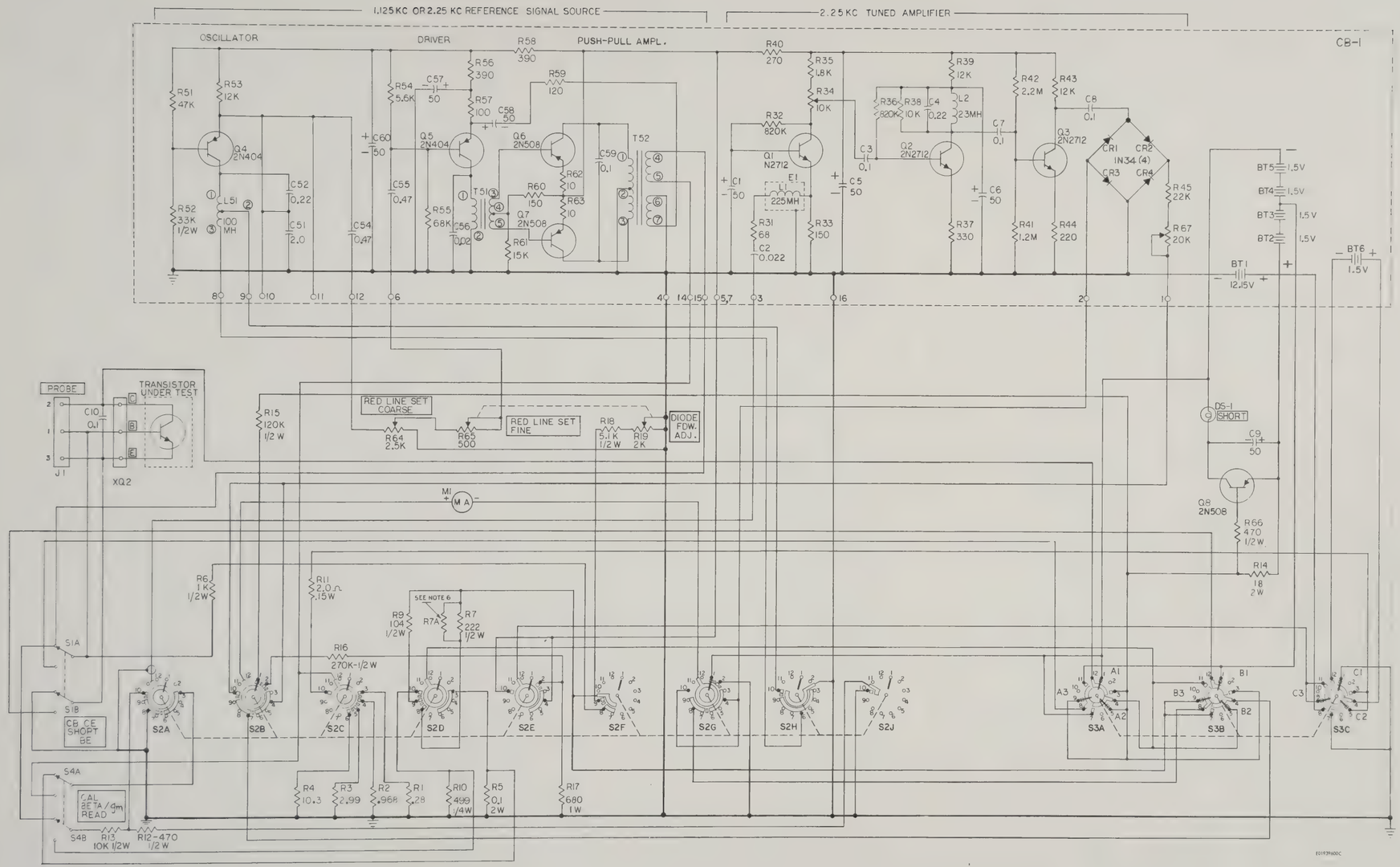


SWITCH FUNCTIONS		
SWITCH NO.	POSITION	FUNCTION
1 SHORT TEST	NORMAL DEPRESSED (SPRING RETURN)	CB, CE SHORT BE SHORT
2 FUNCTION	1 2 3 4 5 6 7 8 9 10	TEST-BAT. 2,3,4,5, TEST BAT. 1 BETA - 3-30 BETA - 10-100 BETA - 30-300 BETA - 100-1000 Ico - 0-50 μA Ico - 0-500 μA DIODE 1-10 F.E.T.
3 POLARITY	1 2 3	PNP (REV.) OFF NPN (FWD)
4 BETA/g_m	NORMAL DEPRESSED (SPRING RETURN)	CALIBRATE READ

NOTE 6

R7A PARALLEL RESISTOR IS FACTORY SELECTED. THE TOTAL VALUE FOR R7 DEPENDS ON METER RESISTANCE.

METER RESISTANCE	R-7
2200	244
2150	239
2100	233
2050	228
1950	217
1900	211
1850	206
1800	200



NOTES:

1. ALL ROTARY SWITCHES SHOWN IN EXTREME COUNTER-CLOCKWISE POSITION AS VIEWED FROM FRONT OR KNOB END OF SWITCH.
2. ALL OTHER SWITCHES SHOWN IN NORMAL POSITIONS.
3. RESISTOR VALUES ARE IN OHMS AND 1/4 WATT UNLESS OTHERWISE NOTED. $K=10^3$, $M=10^6$.
4. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
5. MOVING CONTACT ELEMENT IS REPRESENTED BY BLACK BAR IN ROTARY SWITCH SYMBOLS.

EXAMPLE

SWITCH FUNCTIONS		
SWITCH NO.	POSITION	FUNCTION
1 SHORT TEST	NORMAL DEPRESSED (SPRING RETURN)	CB, CE SHORT BE SHORT
2 FUNCTION	1	TEST-BAT. 2,3,4,5,
	2	TEST BAT. 1
	3	BETA - 3-30
	4	BETA - 10-100
	5	BETA - 30-300
	6	BETA - 100-1000
	7	Ico - 0-50 μA
	8	Ico - 0-500 μA
	9	DIODE 1-10
	10	F.E.T.
3 POLARITY	1	PNP (REV)
	2	OFF
	3	NPN (FWD)
4 BETA/gm	NORMAL DEPRESSED (SPRING RETURN)	CALIBRATE READ

NOTE 6

R7A PARALLEL RESISTOR IS FACTORY SELECTED. THE TOTAL VALUE FOR R7 DEPENDS ON METER RESISTANCE.

METER RESISTANCE	R-7
2200	244
2150	239
2100	233
2050	228
1950	217
1900	211
1850	206
1800	200

00A

Figure 4-5. Model 219C In-Circuit Transistor Tester Schematic Diagram

SECTION V
REPLACEABLE PARTS LIST

PARTS REPLACEMENT

Standard components have been used in this instrument whenever possible. Both standard and special components may be ordered direct from the factory.

When ordering parts always include:

1. Sierra Stock Number.
2. Circuit Reference and Commercial Description.
3. Name, Model and Serial Number of the Instrument.

Parts for this instrument, or further service information may be obtained from:

SIERRA ELECTRONIC DIVISION
Philco Corporation
3885 Bohannon Drive
Menlo Park, California 94025

Telephone (415) 322-7222
TWX 910-373-1282

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
BT1	BATTERY, Mercury, 12.15V	918500011	Mallory	TR-239	1
BT2	BATTERY, Zinc-Carbon, 1.5V, Size AA	918500014	RCA	VS-334	5
BT3	Same as BT2				
BT4	Same as BT2				
BT5	Same as BT2				
BT6	Same as BT2				
C1	CAPACITOR, Electrolytic, 50 mfd, 15V	902210506	Sprague	VL-1174	6
C2	CAPACITOR, Mylar, .022 ±3%, 100V	901100223	Electrocube	EC1-215B-1B223M2	1
C3	CAPACITOR, Ceramic Disc, 0.1, 50V	901410104	Sprague	33C41	4
C4	CAPACITOR, Mylar, 0.22 ±3%, 100V	901100224	Electrocube	EC1-250B-1B224-2	2
C5	Same as C1				
C6	Same as C1				
C7	Same as C3				
C8	Same as C3				
C9	CAPACITOR, Electrolytic, 50 mfd, 10V	902220506	Sprague	TE-1119	1
C10	Same as C3				
C51	CAPACITOR, Mylar, 2.0 µf, 10%, 100V	901100205	Electrocube	EC1-250B-1B205K	1
C52	Same as C4				
C53	Not Used				
C54	CAPACITOR, Ceramic Disc, .47, 12V	901400474	Sprague	HY 330	2
C55	Same as C54				
C56	CAPACITOR, Ceramic, .02 µf ±15%, 1000V	901430203	Sprague	IOTS-S20	1
C57	Same as C1				
C58	Same as C1				
C59	CAPACITOR, Mylar, 0.1 µf, ±10%, 200V	901100104	Cornell-Dubilier	DPMS-2P1	1
C60	Same as C1				
CR1	DIODE, Germanium	910500034	Sylvania	1N34AG	4
CR2	Same as CR1				
CR3	Same as CR1				
CR4	Same as CR1				
DS1	PILOT LIGHT, Incandescent, 6 Volts, 40 ma	913800020	Dialco	39-604-1431	1
J1	RECEPTACLE, Panel, Female	914800066	Elco	EL-00-2215-003	1
J2	CONNECTOR, Male Plug, Cable	914800065	Elco	EL-00-2216-003	1
L1	TOROIDAL INDUCTOR, 225 MH ±1%	909000118	Pulse Engineer.	A01944900	2
L2	TOROIDAL INDUCTOR, 23 MH ±1%	909000119	Pulse Engineer.	A01941200	1
L51	TOROIDAL INDUCTOR, 100 MH ±1%	909000120	Pulse Engineer.	A01941300A	1
M1	METER, 0-50 µA	911800062	Beede Model 230	A01940700	1
Q1	TRANSISTOR, Silicon, 2N2712	910300014	GE		3
Q2	Same as Q1				
Q3	Same as Q1				
Q4	TRANSISTOR, Germ., 2N404	910300007	RCA		2
Q5	Same as Q4				
Q6	TRANSISTOR, Germ., 2N508	910300015	GE		3
Q7	Same as Q6				
Q8	Same as Q6				

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
R1	RESISTOR, 0.28Ω, 1%, 1/4W, W-W	906100069			1
R2	RESISTOR, 0.968Ω, 1%, 1/4W, W-W	906100070			1
R3	RESISTOR, 2.99Ω, 1%, 1/4W, W-W	906100071			1
R4	RESISTOR, 10.3Ω, 1%, 1/4W, W-W	906100072			1
R5	RESISTOR, 0.1Ω, 1%, 2W, W-W	906100033	Cal-R	SA-20	1
R6	RESISTOR, Composition, 1K, 10%, 1/2W	905200102	Allen Bradley	EB	1
R7	RESISTOR, Carbon Film, 222Ω, 1%, 1/2W	907400142	Electra	DC 1/2	1
R8	Not Used				
R9	RESISTOR, Carbon Film, 104Ω, 1%, 1/2W	907400168	Electra	DC 1/2	1
R10	RESISTOR, Carbon Film, 499Ω, 1%, 1/2W	908300031	Electra	DC 1/2	1
R11	RESISTOR, Wirewound, 2 ohms, 1%, .15W	906100015	Gen. Resistor	1N4H16AZ	1
R12	RESISTOR, Composition, 470Ω, 5%, 1/2W	905000471	Allen Bradley	EB	1
R13	RESISTOR, Composition, 10K, 5%, 1/2W	905000103	Allen Bradley	EB	1
R14	RESISTOR, Composition, 18Ω 10%, 2W	906000180	Allen Bradley	HB	1
R15	RESISTOR, Composition, 120K, 5%, 1/2W	905000124	Allen Bradley	EB	1
R16	RESISTOR, Composition, 270K, 5%, 1/2W	905000274	Allen Bradley	EB	1
R17	RESISTOR, Composition, 680Ω, 10%, 1W	905200681	Allen Bradley	GB	1
R18	RESISTOR, Composition, 5.1K, 5%, 1/2W	905000512	Allen Bradley	EB	1
R19	POTENTIOMETER, 2K, 10%, Dual, Ganged with R65	907900162	CTS	2-45	1
R31	RESISTOR, Composition, 68Ω, 10%, 1/4W	907100680	Allen Bradley	CB	1
R32	RESISTOR, Composition, 820K, 10%, 1/4W	907100824	Allen Bradley	CB	2
R33	RESISTOR, Composition, 150Ω, 10%, 1/4W	907100151	Allen Bradley	CB	2
R34	RESISTOR, Wirewound Adjustable, 10K, 10%	907900163	CTS	Ins. 115	1
R35	RESISTOR, Composition, 1.8K, 10%, 1/4W	907100182	Allen Bradley	CB	1
R36	Same as R32				
R37	RESISTOR, Composition, 330Ω, 10%, 1/4W	907100331	Allen Bradley	CB	1
R38	RESISTOR, Composition, 10K, 10%, 1/4W	907100103	Allen Bradley	CB	1
R39	RESISTOR, Composition, 12K, 10%, 1/4W	907100123	Allen Bradley	CB	3
R40	RESISTOR, Composition, 270Ω, 10%, 1/4W	907100271	Allen Bradley	CB	1
R41	RESISTOR, Composition, 1.2 Meg, 10%, 1/4W	907100125	Allen Bradley	CB	1
R42	RESISTOR, Composition, 2.2 Meg, 10%, 1/4W	907100225	Allen Bradley	CB	1
R43	Same as R39				
R44	RESISTOR, Composition, 220Ω, 10%, 1/4W	907100221	Allen Bradley	CB	1
R45	RESISTOR, Composition, 22K, 5%, 1/4W	906900223	Allen Bradley	CB	1
R51	RESISTOR, Composition, 47K, 10%, 1/4W	907100473	Allen Bradley	CB	1
R52	RESISTOR, Composition, 33K, 10%, 1/2W	905200333	Allen Bradley	EB	1
R53	Same as R39				
R54	RESISTOR, Composition, 5.6K, 10%, 1/4W	907100562	Allen Bradley	CB	1
R55	RESISTOR, Composition, 68K, 10%, 1/4W	907100683	Allen Bradley	CB	1
R56	RESISTOR, Composition, 390Ω, 10%, 1/4W	907100391	Allen Bradley	CB	2
R57	RESISTOR, Composition, 100Ω, 10%, 1/4W	907100101	Allen Bradley	CB	1
R58	Same as R56				
R59	RESISTOR, Composition, 120Ω, 10%, 1/4W	907100121	Allen Bradley	CB	1
R60	Same as R33				
R61	RESISTOR, Composition, 15K, 10%, 1/4W	907100153	Allen Bradley	CB	1
R62	RESISTOR, Composition, 10Ω, 5%, 1/4W	906900100	Allen Bradley	CB	2
R63	Same as R62				
R64	POTENTIOMETER, 2500Ω, ±30% Vernier, 10-1/4 Turns	907900114	CTS	VA45	1
R65	POTENTIOMETER, 500Ω, ±10%, Dual, Ganged with R19	(See R19)	CTS	2-45	1
R66	RESISTOR, Composition, 470 Ω, 5%, 1/2W	905000471	Allen Bradley	EB	1
R67	POTENTIOMETER, 20K	907900165	Bourns	3068-S	1
R7A	RESISTOR, Factory Selected, 1/2W				1

REPLACEABLE PARTS LIST

Schem. Ref. No.	Description	Sierra Stock No.	Mfr.	Dwg. or Mfr. No.	Tot. Quan.
S1	SWITCH, Toggle, Spring Return, DPDT	911000024	Smith	1023	2
S2	SWITCH, 8-Pole, 9 Positions	911200105	CTS	A02005700	1
S3	SWITCH, 9-Pole, 3 Positions	911200097	CTS	A01938800	1
S4	Same as S1				
T51	TRANSFORMER, Audio, Driver	909900011	Sierra	A01937600	1
T52	TRANSFORMER, Audio, Output	909900012	Sierra	A01937500	1
XQ1	TRANSISTOR SOCKET	914200019	Elco	3306	1

R-F Wattmeters and Coaxial Terminations

In-Line R-F Power Monitors

Power Attenuators

SIERRA

POWER GENERATION AND MEASUREMENT EQUIPMENT

High-Power Signal Generators

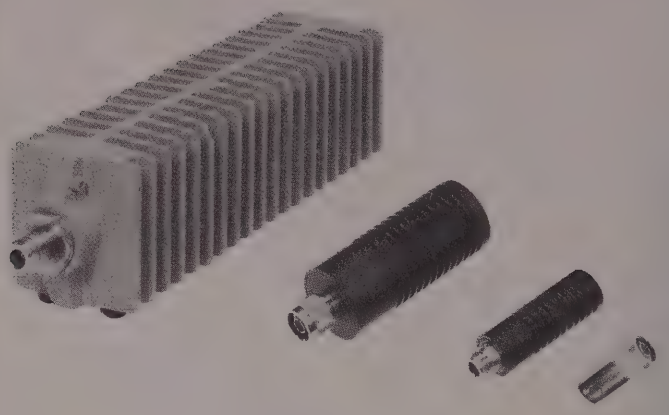
R-F Calorimeters

Thermopiles, Couplers, Detectors and Filters

SIERRA ELECTRONIC DIV.
OF
PHILCO
A SUBSIDIARY OF Ford Motor Company

EDITION No. 3

Sierra Coaxial R-F Terminations for 50-ohm Systems



Sierra coaxial loads provide stable termination of r-f power with nominal 50-ohm impedance and low VSWR. They are used with CW, AM, FM, TV, and radar transmitters and power sources. They permit completely normal operation of the transmitter, except that no r-f signal is radiated. Testing, adjustment, and alignment are facilitated while the load dissipates the r-f energy produced by the transmitter or power source.

Thirteen different termination types are available. Frequency coverage of the widest range models is from DC to 11 GHz. Voltage standing wave ratios are shown in relation to frequency bands, enabling the user to pinpoint the VSWR for the particular frequency of interest.

Many of the terminations described here are equipped with Sierra "Twist-Off" r-f connectors. These readily replaceable connectors permit a choice of eight different connector types and provide the flexibility of changing connectors quickly and easily in the field.

Performance specifications for all Sierra 50-ohm coaxial terminations are shown on these pages. Individual data sheets on each model or series are available on request.

Model 160 Series Dry Coaxial Loads

- ☐ Power Ratings to 100 Watts
- ☐ Broad frequency ranges
- ☐ Dry construction; no dielectric coolant

The dry Model 160 Series terminations are characterized by rugged construction, light weight, and compact size. They are readily portable for use on-site with mobile equipment and field installations, and in the laboratory or test facility. Models rated at 50 and 100 watts are available with "Twist-Off" connectors.

Summary Specifications

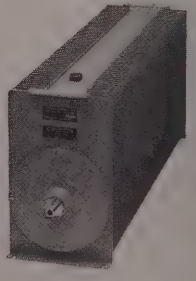
Model	Avg. Power Rating (Watts)	Overload Avg. Pwr. Minutes 50%	100%	Connector Types	Frequency Range	Maximum VSWR	Size & Weight
160-1	1	5	1	N, BNC, TNC	DC-11 GHz (Type N)	1.1 DC-4 GHz 1.15 4-6 GHz 1.25 6-11 GHz	¾" D, 1¾" L, 3 oz.
160-5	5	5	1	N, BNC, TNC	DC-11 GHz (Type N)	1.1 DC-4 GHz 1.2 4-6 GHz 1.5 6-11 GHz	1" D, 3⅛" L, 4½ oz.
160-20	20	5	1	N, BNC, TNC	DC-6 GHz (Type N)	1.1 DC-1 GHz 1.15 1-4 GHz 1.5 4-6 GHz	1⅝" D, 4½" L, 8 oz.
160-50D	50	5	1	Twist-Off*	DC-5 GHz	1.1 DC-1 GHz 1.2 1-4 GHz 1.4 4-5 GHz	2¼" W, 2½"H, 7⅜" L, 1½ lbs.
160-100D	100	5	1	Twist-Off*	DC-5 GHz	1.1 DC-1 GHz 1.2 1-4 GHz 1.4 4-5 GHz	3" W, 3¾" H, 11½" L, 3½ lbs.

* Sierra "Twist-Off" connectors available: Type C, N, HN, LC, BNC, TNC, UHF, 1⅝" rigid line, male and female.

Model 160—1600

Conventional 50-ohm termination for high power dissipation . . .

- ☐ Dissipates 1600 watts with free convection cooling
- ☐ Forced air and water cooling accessories available for 2500-watt or 4000-watt power dissipation
- ☐ VSWR 1.15, DC to 1 GHz
- ☐ Sierra "Twist-Off" connectors to fit wide variety of applications



Model 460A Series
Conduction-Cooled Coaxial Loads

The novel design concept utilized in the 460A Series permits the construction of high-power terminations in the smallest, lightest-weight packages available.

These dry terminations are designed specifically for use in space vehicles, missiles, and other applications which require high power dissipation but do not permit convection cooling. They are unaffected by high-altitude conditions or mounting position. Their rugged construction permits operation in unfavorable environments.

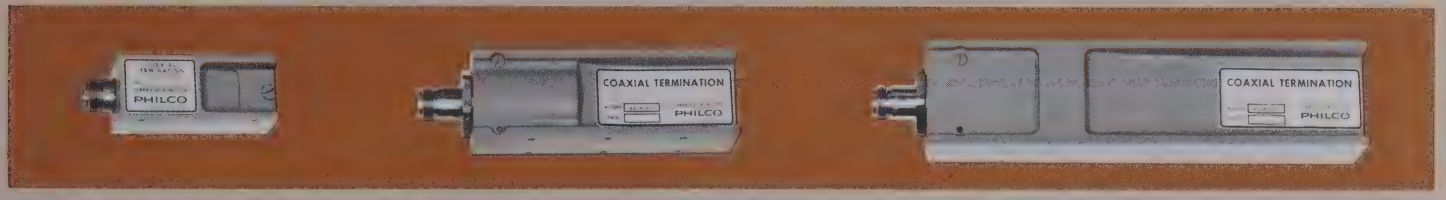
Sierra 460A loads may be attached directly to an equipment cabinet, bulkhead, air-frame, or other structure which can serve as a heat sink. They operate in any position and in any atmosphere.

"Twist-Off" r-f connectors on most models give the user the added flexibility of changing connectors quickly and easily in the field.

Summary Specifications

Model	Power Rating — Watts: Heat Sink both sides at 55°C	Power Rating — Watts: Heat Sink one side at 55°C	Frequency Range	Maximum VSWR	Size & Weight
460A-150	150	120	DC-4 GHz	1.1 DC-500 MHz 1.15 500 MHz-1 GHz 1.2 1-2 GHz 1.25 2-4 GHz	1.281" W, 1.140" H, 3.5" L, 6 oz.
460A-400	400	320	DC-4 GHz	1.1 DC-500 MHz 1.15 500 MHz-1 GHz 1.2 1-2 GHz 1.25 2-4 GHz	1.406" W, 1.515" H, 5.625" L, 13 oz.
460A-1000	1000	700	DC-4 GHz	1.1 DC-500 MHz 1.15 500 MHz-1 GHz 1.2 1-2 GHz 1.25 2-4 GHz	2.032" W, 1.765" H, 8.375" L, 1 lb. 10 oz.

Note: Models 460A-400 and 460A-1000 are available with "Twist-Off" connectors, Types N, C, HN, LC, BNC, TNC, and 1⅝" rigid line, male or female.



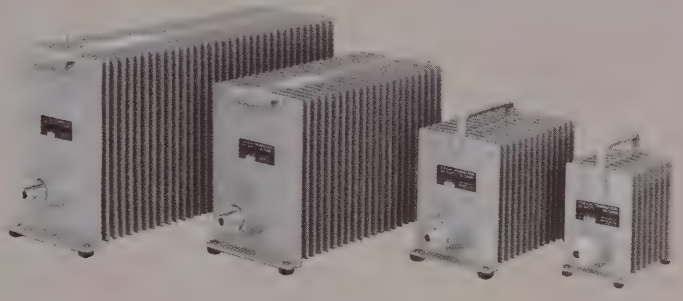
Model 160B Series
Silicone Dielectric Coaxial Loads

Sierra Model 160B coaxial loads are used with transmitters operating up to 5 GHz or as terminations for use with in-line power monitors such as the Sierra 164B or 400A.

These loads utilize a new form of construction which results in smaller size, lighter weight, and longer life than conventional loads. The body of the load is a rugged aluminum casting, permitting optimum heat transfer for maximum thermal efficiency. Infrared heat distribution patterns show this construction to be more effective than conventionally fabricated loads in transferring heat from the load resistor to the ambient air.

Model 160B terminations are sealed units, without the customary bellows or air vents. They are filled with silicone dielectric fluid rather than oil. This offers the advantage of longer life because the silicone does not tend to carbonize with repeated temperature cycling, and it permits the unit to be sealed to minimize the possibility of leakage.

Sierra "Twist-Off" r-f connectors are included with all models in this series. Eight different connector types can be replaced on the load quickly and easily.



Summary Specifications

Model	Avg. Power Rating (Watts)	Overload Avg. Pwr. Minutes 50%	Overload Avg. Pwr. Minutes 100%	Frequency Range	Maximum VSWR	Size & Weight
160B-150	150	10	5	DC-4 GHz	1.1 DC-500 MHz 1.2 500 MHz-4 GHz	3½" W, 6" H, 6½" L, 2¾ lbs.
160B-300	300	10	5	DC-4 GHz	1.1 DC-1 GHz 1.2 1-4 GHz	4⅞" W, 7⅜" H, 9¾" L, 6¾ lbs.
160B-600	600	10	5	DC-5 GHz	1.1 DC-1 GHz 1.2 1-3 GHz 1.5 3-5 GHz	6" W, 8¼" H, 14" L, 15½ lbs.
160B-1000	1000	10	5	DC-5 GHz	1.1 DC-1 GHz 1.2 1-3 GHz 1.5 3-5 GHz	6⅜" W, 9⅜" H, 20" L, 29½ lbs.

All models in Series 160B are fitted with Sierra "Twist-Off" connectors. Connector options available are: Type N, UHF, C, LC, HN, BNC, TNC, and 1⅝" rigid line, male or female.

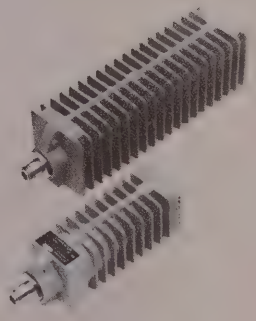
Coaxial Power Attenuators

Designed for 50-ohm systems, the Sierra Model 660 Series of attenuators are dry, unidirectional attenuators operating up to 1 GHz. They extend the range of a low-power calorimeter or power meter by a factor of 100 or 1,000. They are also useful for signal monitoring and sampling purposes, producing an output that is 20 or 30 db below the input signal.

Summary Specifications

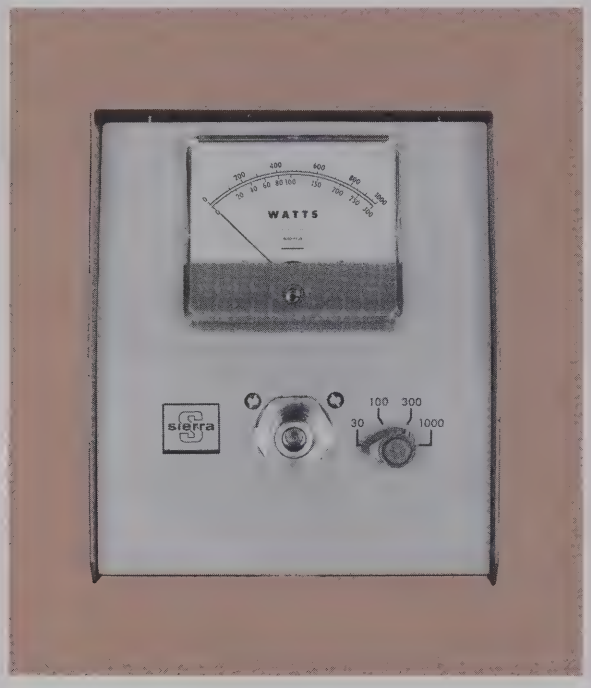
Model	Attenuation	Power Rating (Watts)	Frequency Range	Accuracy	Maximum VSWR	Size & Weight
661A-20	20 db	50	DC-1 GHz	±1 db	1.1 DC-1 GHz	2¼" W, 2½" H, 8¼" L, 1 lb. 10 oz.
661A-30	30 db	50	DC-1 GHz	±1 db	1.1 DC-1 GHz	2¼" W, 2½" H, 8¼" L, 1 lb. 10 oz.
662A-20	20 db	100	DC-1 GHz	±1 db	1.1 DC-1 GHz	3" W, 3¼" H, 12¼" L, 3 lbs. 10 oz.
662A-30	30 db	100	DC-1 GHz	±1 db	1.1 DC-1 GHz	3" W, 3¼" H, 12¼" L, 3 lbs. 10 oz.

Note: R-f input connectors are Sierra "Twist-Off," Types N, C, BNC, TNC, HN, LC (male and female), and 1⅝" rigid line. R-f output connectors are Type N female.



Sierra R-F Termination Wattmeters

Sierra termination wattmeters are direct-reading instruments which absorb and measure r-f power up to 1,000 watts at frequencies from 2 to 1,000 MHz. They are designed for use with 50-ohm coaxial systems.



Model 401A-1000L front panel illustrates the functional design of this series of wattmeters. The power range selector switch, shown in the 30-watt position, is the only operating control. With the switch in this position, the meter will indicate 30 watts full scale. Power levels as low as 2 watts can be readily measured.

These instruments provide exceptional versatility of application. On all except the smallest models, any one of four power ranges can be selected with a front-panel switch. Dynamic range of 500 to 1 makes it possible for the user to read meter indications as low as 2 watts on the Model 401A-1000, 1 watt on the Model 401A-500, and 0.5 watt on the Model 401A-250.

The clean, uncluttered design of the front panel lends itself further to rapid, accurate operation of the instrument. The r-f connector, range selector switch, and large meter with partially expanded scale for easy reading are the only elements on the panel. To measure power with the instrument, it is only necessary to connect the coaxial line and switch to the appropriate power range.

Sierra "Twist-Off" r-f connectors are used on all Sierra termination wattmeters (except Model 185A). This permits the user a choice of eight different connector types and provides the added flexibility of changing connectors quickly and easily in the field.

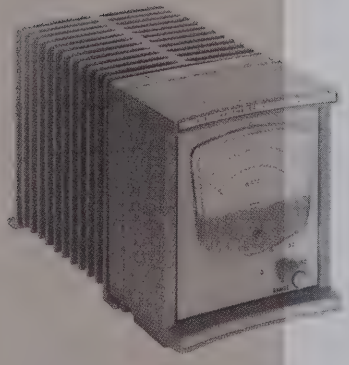
Sierra termination wattmeters are ruggedly constructed to withstand years of use under the environmental conditions of field operation. The termination, or power-dissipating element, is sturdy cast aluminum. Infrared heat distribution patterns show this construction to be more effective than conventionally fabricated loads in transferring heat from the load resistor to the ambient air. Non-carbonizing silicone fluid is used instead of the conventional oil dielectric, providing longer life under repeated heat cycling. The termination itself is sealed, with no bellows or air vents. This minimizes the possibility of coolant leakage and prevents contamination of the coolant by atmospheric impurities.

Performance specifications for all Sierra termination wattmeters are shown on these pages. Individual data sheets on each model or series are available on request.

Summary Specifications

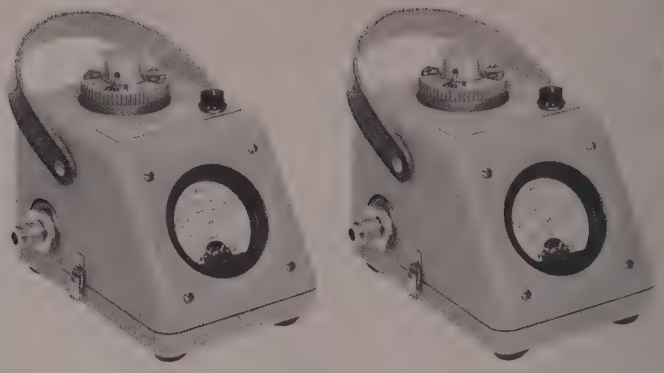
Model	Maximum Power Rating (Watts)	Power Ranges (Watts)	Frequency Range (MHz)	Accuracy % Full Scale	Maximum VSWR	Size & Weight
401A-120L	120	0-30 0-120	2-30	±5%	1.2	
401A-120M	120	0-30 0-120	30-500	±5%	1.2	3½" W, 6" H, 8⅝" L, 4⅞ lbs.
401A-120H	120	0-30 0-120	400-1000	±5%	1.2	
401A-250L	250	0-7 0-25 0-70 0-250	2-30	±5%	1.2	
401A-250M	250	0-7 0-25 0-70 0-250	30-500	±5%	1.2	4⅞" W, 7⅜" H, 13" L, 9 lbs.
401A-500L	500	0-15 0-50 0-150 0-500	2-30	±5%	1.2	
401A-500M	500	0-15 0-50 0-150 0-500	30-500	±5%	1.2	6" W, 8¼" H, 17¼" L, 18 lbs.
401A-1000L	1000	0-30 0-100 0-300 0-1000	2-30	±5%	1.2	
401A-1000M	1000	0-30 0-100 0-300 0-1000	30-500	±5%	1.2	6⅜" W, 9⅜" H, 23" L, 33 lbs.
185A-150	150	0-3 0-15 0-50 0-150	20-1000	±5%	1.2	$5\frac{1}{16}$" W, 6⅛" H, 11¾" L, 10¾ lbs.

Note: Sierra "Twist-Off" connectors are available for Model 401A Series Wattmeters in Types N, UHF, C, LC, HN, BNC, TNC, and 1⅝" rigid coaxial line.
Model 185A-150 is furnished with female Type N r-f input connector.



Model 185A-150 combines broad frequency coverage with unusual power-measurement flexibility. Four power ranges enable the user to make r-f measurements from a fraction of a watt to 150 watts with ease. Frequency coverage of 20 MHz to 1000 MHz permits the Model 185A-150 to be used with equipment operating in the HF, VHF, and UHF bands.

Sierra In-line R-F Wattmeters



Sierra in-line r-f wattmeters are portable test instruments which are used in 50-ohm transmission systems for the measurement of both forward and reflected power. Two separate models are available for use with either CW or pulsed systems.

These instruments provide direct power measurements in watts. They permit antennas or loads to be matched to transmitters or other power sources simply by monitoring the reflected power during actual operation. Tuning the equipment for minimum reflected power indicates that the best possible match has been obtained.

In addition to power measurements, Sierra in-line r-f wattmeters are equipped with direct-reading VSWR meter scales. This feature makes it possible to read the voltage standing wave ratio in a transmission system directly from the wattmeter, without the use of formulas or calculations.

Model 164B In-Line R-F Wattmeter

This instrument is used for power measurements in all types of CW systems. It connects directly into the transmission line and measures power delivered to the load as well as power reflected from the load. It is not necessary to change r-f connections in order to reverse the direction of power measurement.

Model 164B covers a power range of 1 to 5000 watts and a frequency range of 2 to 1000 MHz. The specific power and frequency which can be measured depend on the plug-in element used. Each of the ten available plug-in elements covers a relatively wide frequency range and provides four full-scale power ranges. Measurements can be made over a wide dynamic range without changing the plug-in element. This means the user can switch to a lower range when observing reflected power, thus increasing reading accuracy.

To increase the utility of the 164B, the plug-in elements can be readily calibrated in the field. It is not necessary to return them to the factory for calibration. A simple adjustment with a screwdriver and Allen wrench is all that is required. This feature considerably increases the usefulness of the instrument in field operations.

The Sierra Model 164B is furnished with "Twist-Off" r-f connectors. Eight different connector types may be interchanged to accommodate virtually all 50-ohm transmission lines.

A rugged carrying case, Model 164-CC, is available to house the wattmeter and three additional plug-in elements. A transmission line section, Model 164-LS, is also available as an accessory to prevent detuning due to changes in line length when the power monitor is removed after tuning a transmitter operating into a line which is not flat.

Summary Specifications

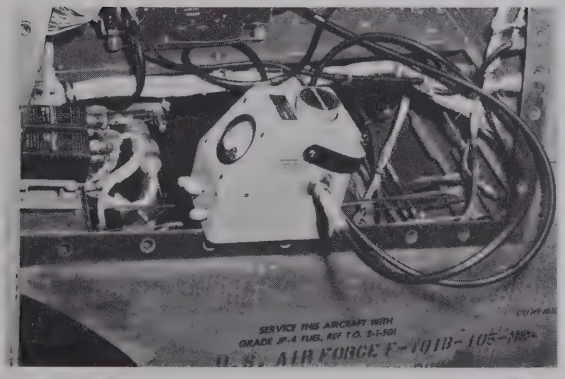
Model 164B Wattmeter only

Insertion VSWR	With Type N connectors, less than 1.08 except on 1-watt ranges
Accuracy	±5% full scale, all ranges
Impedance	50 ohms
Weight	7½ lbs. with one plug-in element
Connectors	Sierra "Twist-Off" (see note)

Note: Type N connectors are normally furnished unless specified otherwise. "Twist-Off" connectors available are Types N, UHF, LC, HN, C, BNC, TNC, and 1⅝" rigid line, male or female.

Plug-In Elements for 164B Wattmeter

Model	Frequency Range (MHz)	Power Ranges (Watts)
180A-52	25-52	1, 5, 10, 50
180A-148	50-148	1, 5, 10, 50
180A-470	144-470	1, 5, 10, 50
180A-1000	460-1000	1, 5, 10, 50
181A-250	25-250	10, 50, 100, 500
181A-1000	200-1000	10, 50, 100, 500
270A-30	2-30	50, 100, 500, 1000
270A-75	10-75	50, 100, 500, 1000
270A-470	70-470	50, 100, 500, 1000
271A-30	2-30	100, 500, 1000, 5000



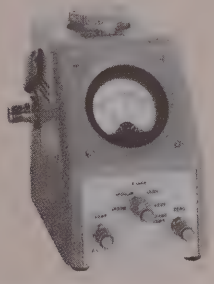
Model 400A in use during testing of jet aircraft antenna. The two peak power ranges of the instrument permit it to measure both incident and reflected energy in medium-power applications such as that shown.
Photo courtesy of U.S. Air Force.

Model 400A Peak R-F Wattmeter

Model 400A is used to monitor both incident and reflected peak pulse power in 50-ohm transmission systems operating between 960 and 1215 MHz. The instrument is furnished with two peak power ranges. The lower range (0 to 500 watts) permits accurate measurement of low-power reflected waves. The higher range (0 to 5000 watts) covers most medium-power measurement applications. The monitor will accept pulses as narrow as 0.1 microsecond at duty cycles as low as 0.01%.

The Sierra Model 400A is equipped with a direct-reading VSWR scale for use when the incident power is 500 watts or higher. A VSWR graph is provided for lower incident power levels.

Applications for Model 400A include monitoring the performance of pulsed r-f systems such as TACAN, DME, transponders, and other navigational aids. The instrument is self-contained and does not require auxiliary equipment.

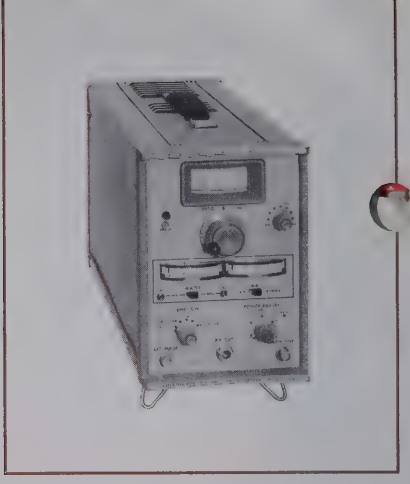


Summary Specifications

Model 400A Peak R-F Wattmeter

Peak Power Ranges	0-500 watts 0-5000 watts
Minimum Duty Cycle	0.01%
Minimum Pulse Width	0.1 microsecond
Accuracy	±10% of full scale
Frequency Range	960-1215 MHz
Insertion VSWR	1.15 maximum
Connectors	Type N
Power Required	115 or 230 VAC ±10% 50-1000 Hz
Weight	11 lbs.

Sierra High-Power Signal Generators



Sierra Model 470A Series high-power signal generators are used for any application which requires a stable source of controllable r-f power higher than that obtainable from milliwatt-level signal generators. Applications include testing and calibration of VHF, UHF, and microwave power-measuring equipment and other r-f devices such as filters, detectors, antenna systems, attenuators, and couplers. They are excellent drivers for power amplifiers and signal sources in RFI testing applications.

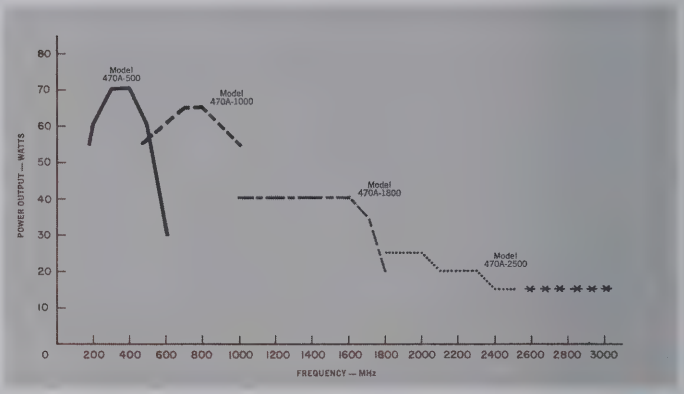
The four instruments in this Series cover the frequency range 200 MHz to 2500 MHz. In addition, usable power output is available down to 190 MHz and up to 3000 MHz. Maximum power output is highest (approximately 70 watts) at 400 MHz and lowest (15 watts) at 2500 MHz. Both the power output and the grid and cathode currents are monitored on front-panel meters.

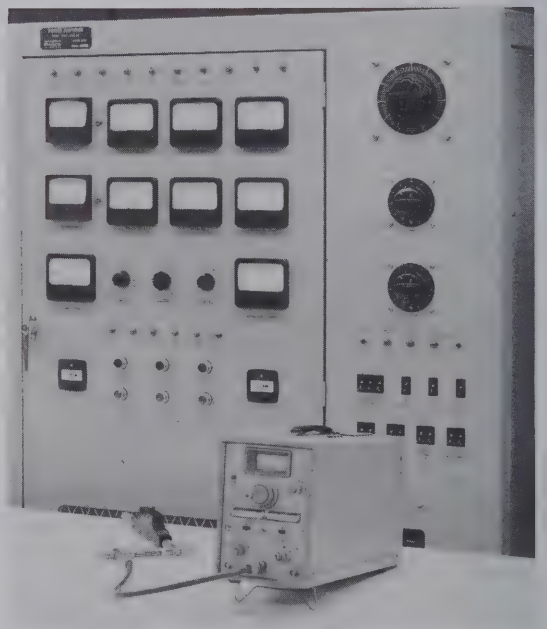
These instruments are capable of either CW, internal or external square-wave, or pulse-modulated outputs. A monitor output jack provides a signal approximately 35 db down from the main output which is particularly useful for wave form analysis and frequency calibration. Frequency stability of the main output is 0.003% per ten minutes or 0.01% per hour average. Power level stability is ±0.2 db per hour after warmup. All filament and high-voltage power supplies are regulated. Reliability is enhanced by the use of all solid-state components (except power output tube) and a unique SCR output power control.

Simplified maintenance is assured by the use of a standard, readily available tube type in the final power output stage. Only a few minutes are required to replace the tube. Disassembly of the cavity is not necessary. In addition, the tube is protected against excessive grid current caused by overload or no-load conditions. A relay circuit with manual reset provides automatic protection.

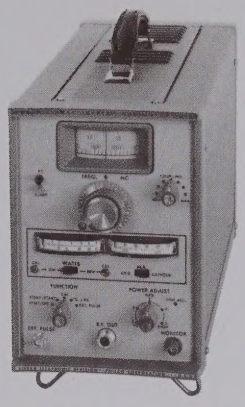
The Sierra 470A signal generators weigh less than forty pounds each. All models are of uniform dimensions and have identical front-panel configurations.

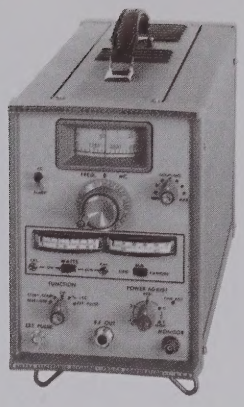
Performance specifications for the Sierra 470A Series are summarized on these pages. Individual data sheets containing more detailed specifications are available on request.





Model 470A-2500 used as driver for 10-kilowatt klystron amplifier. The excellent power and frequency stability of this instrument permits its use in this application. Operating through a low-pass filter and small variable attenuator, the 470A-2500 eliminates the need for a separate signal generator and TWT amplifier to drive the four-cavity narrowband klystron.





Summary Specifications

Model	Frequency Range (MHz)	Power Output (Watts)	Frequency Stability	Power Output Stability	Size & Weight
470A-500	200-500*	55@190 MHz 60@200 MHz 70@300 MHz 70@400 MHz 60@500 MHz 30@600 MHz	0.02%/hr after warmup	±0.2 db/hr after warmup	6¾" W, 10" H, 18½" L, 37 lbs.
470A-1000	470-1000	55@470 MHz 60@600 MHz 65@700 MHz 65@800 MHz 60@900 MHz 55@1000 MHz	0.005%/hr after warmup	±0.2 db/hr after warmup	6¾" W, 10" H, 18½" L, 35 lbs.
470A-1800	1000-1800	40@1000 MHz 40@1100 MHz 40@1200 MHz 40@1300 MHz 40@1400 MHz 40@1500 MHz 40@1600 MHz 35@1700 MHz 20@1800 MHz	0.01%/hr after warmup	±0.2 db/hr after warmup	6¾" W, 10" H, 18½" L, 36 lbs.
470A-2500	1800-2500**	25@1800 MHz 25@1900 MHz 25@2000 MHz 20@2100 MHz 20@2200 MHz 20@2300 MHz 15@2400 MHz 15@2500 MHz	0.01%/hr after warmup	±0.2 db/hr after warmup	6¾" W, 10" H, 18½" L, 37 lbs.

* Usable range 190-600 MHz
** Usable range 1800-3000 MHz

Sierra
R-F Calorimeters

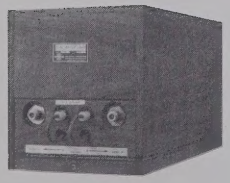
Sierra r-f calorimeters are used for precise measurement of r-f power at levels ranging from 10 watts to 1500 watts, at frequencies from DC to 12.4 GHz.

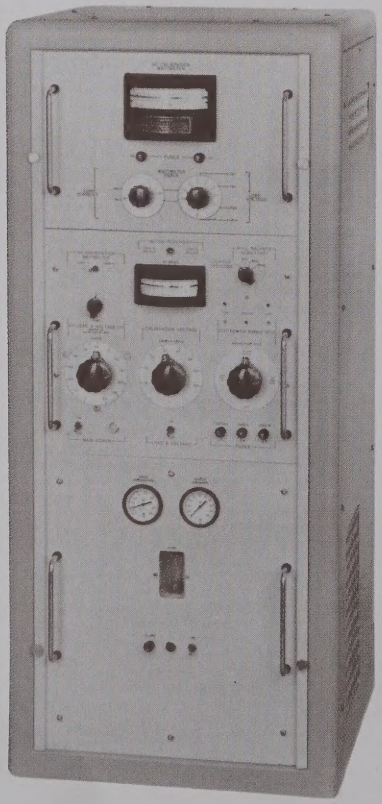
Sierra r-f calorimeters present an unusual degree of versatility and convenience to the user. The small, easily portable Model 430A is a bench-top instrument which requires a minimum of working space. It provides fast r-f power measurements to an error-limit of 3% of the reading.

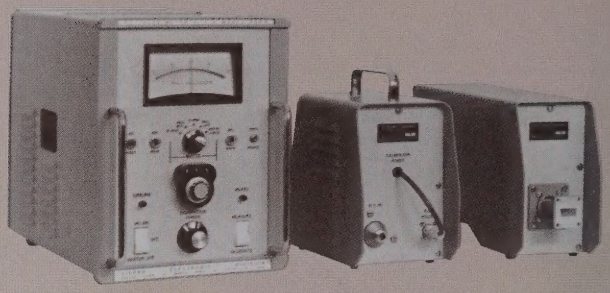
For laboratory precision and highest measurement accuracy, the Sierra Model 290D calorimeter is unexcelled by any system available to the industry. This instrument, with its associated balanced, dual water loads, operates with a total limit of error of only ±1.0%, ±0.1 watt, at any frequency up to 12.4 GHz.

The design of Model 290D utilizes a balanced measurement configuration. Three measurement modes are available: null-balance for maximum accuracy, direct-reading for maximum speed, and a differential mode for measurements where expanded-scale readings are advantageous.

The complete test system consists of the Model 290D calorimeter and an appropriate Model 286 or 287 series dual-load unit. The 290D includes the heat exchanger, calorimeter, and wattmeter assemblies, mounted in an enclosed cabinet. The wattmeter panel contains an a-c wattmeter with certified accuracy of 0.25% full scale. The dual-load units consist of two identical r-f terminations (either coaxial or waveguide), a 90-element differential thermopile, and associated components.







Summary Specifications

Model 430A R-F Calorimeter

Power Range, watts	
Direct Reading	10-1500
Substitution	10-500
Frequency Range	
Termination Loads	DC-12.4 GHz
Accuracy (excluding line-frequency variations)	Limit of error
50-1500 watts	less than 3% of reading
10-50 watts	less than 7% of reading
Dimensions (less load units)	
Height	13″
Width	10″
Depth	18¼″
Weight (including coolant)	55 lbs.

Load Units

Model	Frequency Range (GHz)	Power (KW) Avg.	Power (KW) Peak	Connectors	Weight (lbs.)
450A	DC- 4.0	1.5	10	Type N female	17½
451A-SC	4.0- 5.8	1.5	750	UG-149/U	20
451A-C	5.6- 8.2	1.5	500	UG-344/U	16
451A-XB	7.0-10.0	1.5	300	UG-51/U	13
451A-X	8.2-12.4	1.5	150	UG-39/U	11

Summary Specifications

Model 290D R-F Calorimeter

Full-Scale Measurement Limits	
Null-balance mode	30-1000 watts
Direct-reading mode	10-1500 watts
Differential mode	10-1500 watts
Accuracy	±1.0%, ±0.1 watt limit of error
Calibration Power	variable up to 1200 watts to each individual load
AC Wattmeter Ranges	50, 100, 125, 250, 500, and 1000 watts
Galvanometer Ranges	variable between 15 and 1500 watts full scale
Dimensions	
Height	57″
Width	23¼″
Depth	22″

Dual Water Loads

Model	Frequency Range (GHz)	Maximum VSWR	Connectors	Dimensions
286B	DC- 4.0	1.25	Type N female	9¼″ W, 10⅝″ H, 21″ L
287A-SC	4.0- 5.8	1.10	UG-149A/U	9½″ W, 9⅜″ H, 32½″ L
287A-C	5.8- 8.2	1.10	UG-344/U	9¼″ W, 10⅝″ H, 25¼″ L
287A-XB	7.0-10.0	1.10	UG-51/U	9¼″ W, 10⅝″ H, 25¼″ L
287A-X	8.2-12.4	1.10	UG-39/U	9¼″ W, 10⅝″ H, 20½″ L

Sierra Differential Thermopiles

Sierra differential thermopiles are used in calorimetric applications where a temperature difference in flowing liquids must be converted into electrical energy. Thermopile output is a voltage directly proportional to the temperature difference. Liquids at pressures not exceeding 75 psig may be passed through the thermopile. Voltage outputs: Model 189B, 1.7 mv/°C; Model 389B, 3.4 mv/°C.

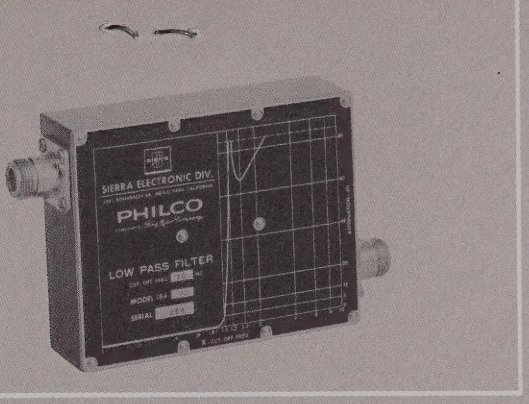
Sierra Directional Couplers

Sierra Model 640 Series coaxial directional couplers are used in measurements of VSWR, reflection coefficients, and power in 50-ohm systems from 1 MHz to 1200 MHz. Their wideband characteristics allow transmission-line measurements over frequency ranges much greater than one octave. They can be used at power levels up to 1000 watts. Maximum VSWR of the coupler is only 1.15.

These directional couplers provide a number of significant advantages to the user. They offer excellent directivity (30 db above 10 MHz). They permit changing the secondary line termination, which allows flexibility of secondary line power levels. The coupling factor changes exactly 6 db per frequency octave so that the exact coupling factor at any point in the unit's frequency range can be quickly calculated.

Sierra Crystal Detector

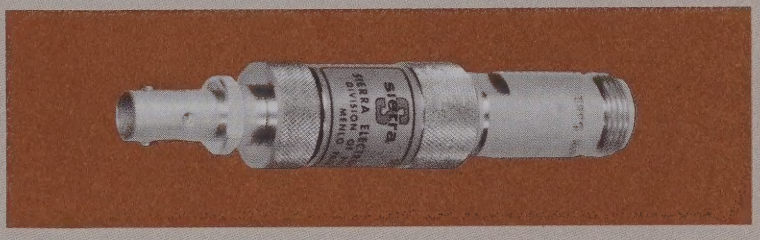
The Sierra Model 148 crystal detector is used in either 50-ohm or 75-ohm coaxial systems from 30 MHz to 1200 MHz. As a detector or demodulator, the unit will accept input powers up to 80 milliwatts. The maximum VSWR is 1.5. Any Model 148 crystal detector can be quickly converted from 50-ohm to 75-ohm impedance or the reverse simply by replacing an interchangeable terminating resistor.



Sierra Low-Pass Filters

Sierra Model 184 Series low-pass filters combine exceptional rejection capabilities with frequency coverage from 20 MHz to 400 MHz. At the worst case, these filters provide rejection approximately 64 db down; over most of the frequency band, rejection is greater than 80 db. Insertion loss is not more than 0.8 db up to 0.9 f_c (cut-off frequency).

Sierra low-pass filters are used to eliminate harmonics in signal generators, transmitters, and power-measuring equipment; when making measurements with slotted lines and directional couplers; and in making receiver response measurements and calibrating r-f voltmeters.



General Information

ACCURACY: Most average-reading r-f wattmeters employing diode detection have accuracies within ±5% of full scale. Any reading on a specific wattage range is accurate to within ±5% of the full scale value for that range. For example, a reading of 20 watts on the 50-watt range would be accurate to within ±2.5 watts (±5% of 50 watts). All Sierra r-f power-measuring equipment is calibrated with a Sierra Model 290 calorimeter accurate within ±1%.

OUT-OF-BAND OPERATION: Wattmeter accuracy is seriously degraded when the instrument is operated outside of the specified frequency range. Correction curves do not serve to compensate for these inaccuracies because the degradation varies with each instrument. Terminations may be operated beyond their frequency limits with probable increases in VSWR.

OVERLOAD CONDITIONS: Conservative short-time overload specifications are shown for Model 160 and 160B terminations. Excessive overloading of a termination will not necessarily cause complete failure; however, high VSWR can result from permanent changes in the impedance of the device.

OPERATING POSITION OF TERMINATIONS: Dry loads such as the 160 Series can usually be operated in any position. Dielectric-filled loads must be operated with the feet down. It is always good practice to operate a convection-cooled load with the fins in a vertical plane. Series 460A conduction-cooled loads are designed for continuous operation in any position.

FIELD CALIBRATION: Model 164 with plug-ins and Model 401 and 185 termination wattmeters can be calibrated in the field. Another Model 164 with plug-in, known to be in calibration, is used as a working standard. This instrument is connected in series with the meter to be calibrated.

CONNECTOR OPTIONS: The r-f connectors shown below can be readily interchanged in the field on instruments fitted with Sierra "Twist-Off" connectors. Stock numbers are shown for ordering convenience.

Sierra "Twist-Off" R-F Connectors

Type	Stock Number	Type	Stock Number
N	914600012 male 914600013 female	LC	914600080 male 914600075 female
C	914600082 male 914600081 female	BNC	914600083 male 914600076 female
UHF	914600022 male 914600023 female	TNC	914600085 male 914600084 female
HN	914600078 male 914600079 female	1⅝" rigid line	914600071